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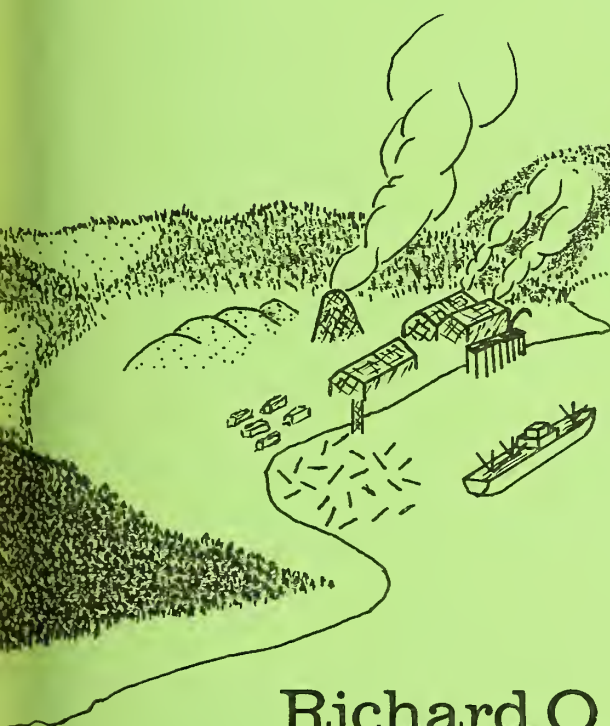
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USDA FOREST SERVICE RESEARCH PAPER PNW-208

1976

Western Hemlock in Southeast Alaska-- Utilization, Lumber Recovery, and Chip Yield



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METRIC CONVERSION TABLE

1 inch	= 2.540 centimeters
1 foot	= 0.305 meter
1 cubic foot	= 0.028 cubic meter
1 pound	= 0.453 kilogram

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WESTERN HEMLOCK IN SOUTHEAST ALASKA--UTILIZATION, LUMBER RECOVERY, AND CHIP YIELD

Reference Abstract

- Woodfin, Richard O., Jr., and Thomas A. Snellgrove.
1976. Western hemlock in southeast Alaska--utilization,
lumber recovery, and chip yield. USDA For. Serv. Res.
Pap. PNW-208, 33 p., illus. Pacific Northwest Forest
and Range Experiment Station, Portland, Oregon.

Lumber recovery from western hemlock from southeast Alaska National Forest land is presented with cubic volume yields, cull log lumber recovery, estimates of chippable wood, and logging residue from sample trees.

KEYWORDS: Western hemlock, *Tsuga heterophylla*, wood utilization, lumber yield studies, sawmill recovery studies, log grading, cubic volume measure, chip production, southeast Alaska.

RESEARCH SUMMARY

Research Paper PNW-208

1976

This report presents lumber recovery information on a sample of western hemlock trees selected from southeast Alaska National Forest land and sawn at a southeast Alaska mill cutting for the Japan export market.

A total of 1,261 sawn-length logs produced about 335,400 board feet of lumber. Over 88 percent of this volume was in 4-inch-thick items, primarily nominal 4 by 4's.

Sawing the 1,165 noncull logs resulted in a 20-percent overrun from net scale. The cubic lumber recovery was 48 percent of the gross cubic log volume. In contrast, the 96 cull logs yielded only a 26-percent cubic recovery.

Lumber grade recovery was concentrated in two grades, Standard and Construction.

Average scaled defect for the 1,165 sawn, noncull logs was 19.6 percent. Defect percentages were lowest for the Peeler and No. 3 grade logs.

The calculated pounds of oven-dry chippable wood varied substantially over the diameter range.

Logging residue accounted for 23.3 percent of the total tree volume. Residue types recognized were broken logs, long butts, unused volume to an 8-inch top (includes cull logs left in the woods), and the volume between the used top and total height. These amounted to 3.2 percent, 5.7 percent, 3.6 percent, and 10.8 percent, respectively, of total tree volume.

Introduction

Southeast Alaska contains an estimated 107 billion board feet of old-growth western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) sawtimber (USDA Forest Service 1973) which represents about 43 percent of the western hemlock sawtimber in the Western United States. About 39 percent of this sawtimber volume is in the 21- to 30-inch diameter range; another 30 percent is in larger trees (Hutchison 1967). Less than 5 percent is comprised of the higher quality Peeler and No. 1 grade logs.¹

Alaska's forest products industry is principally export oriented with the major volume of lumber manufactured as cants designated for Japan. The pulp mills and sawmills are primary manufacturing plants whose output is further processed by secondary plants to obtain finished products.

Western hemlock provided only about 14 percent of the total volume of cants and lumber exported from southeast Alaska in 1967; by 1973 this had increased to 52 percent. Western hemlock from Alaska now comprises about 15.8 percent of the total amount of softwood lumber exported from the west coast and about 55 percent of all the western hemlock exported from the west coast. Such increases point up the need for periodically updating lumber recovery information.

Objectives

This paper presents the results of a 1970 study to determine lumber recovery volumes and grade yields from a representative sample of western hemlock sawtimber in southeast Alaska. This lumber yield information, produced under current industrial manufacturing practices, can provide the Alaska forest products industry and public agencies with an improved basis for determining timber value and estimating product yields.

Timber quality log surface characteristics were identified, measured, and recorded for all the trees processed. The relationship of these characteristics to lumber yield is being used to develop improved log grading and tree valuation systems for western hemlock.

Procedures

Timber Sample

Approximately 360 trees were selected from 12 sample areas on the North and South Tongass National Forests. Figure 1 shows the approximate location of the areas. From each of these areas, approximately 30 trees were selected to represent the size and quality of timber available to a southeast Alaska sawmill rather than the normal log mix of a mill. This permits any southeast Alaska mill to apply the study results to its particular log grade and diameter mix. Sample stratification was by tree size and a quality determination that was the grade (USDA Forest Service 1959) of the first 16-foot log in each tree.

¹Grade as defined by USDA Forest Service (1959).

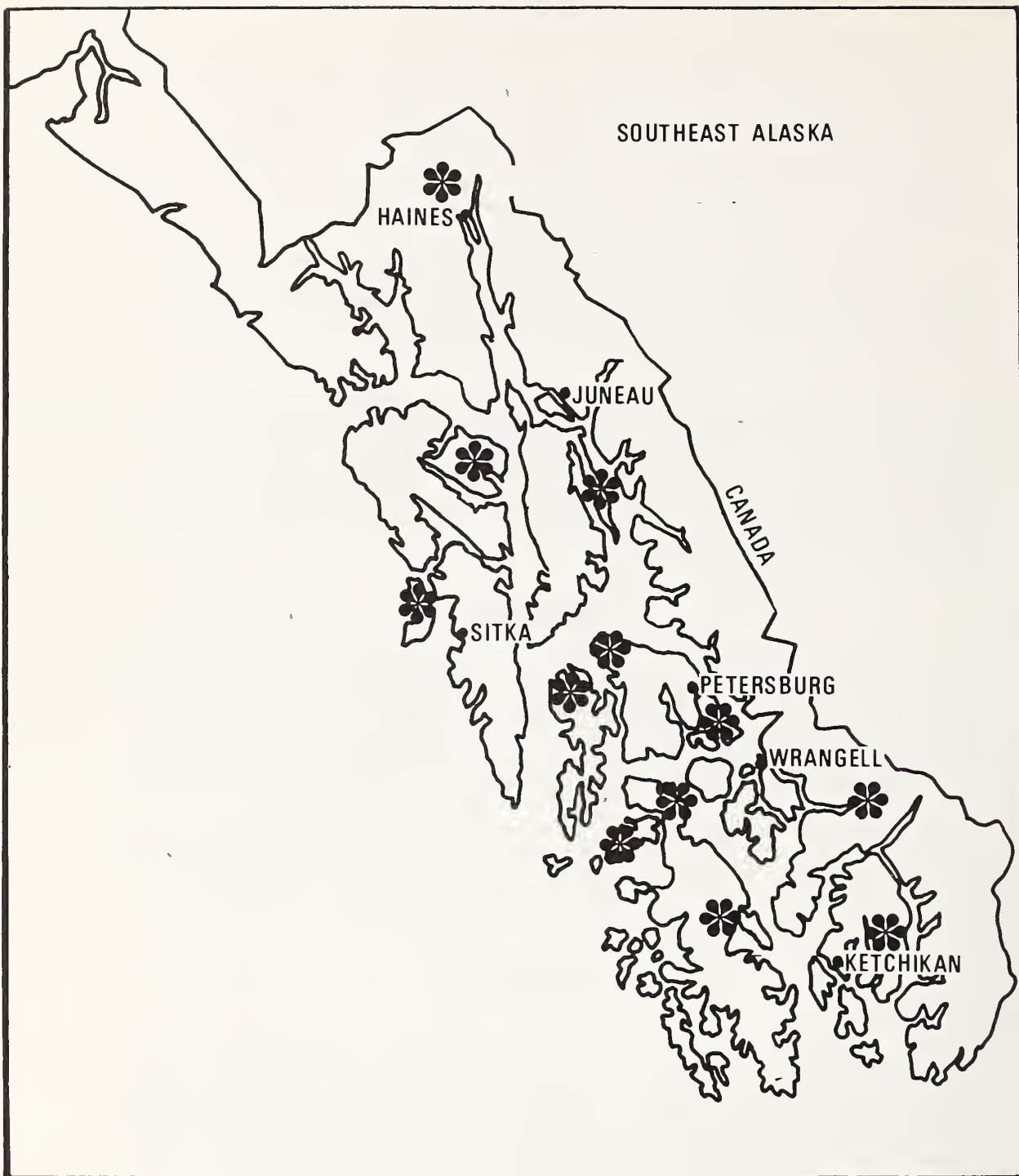


Figure 1.--Approximate location of the 12 sample areas.

Logging, Identification, and Diagraming

The study trees were felled and bucked into saw logs by cooperating logging contractors according to normal industry practice in southeast Alaska. Each log was tagged in the woods to identify its origin with respect to tree and position in the tree. All logs were skidded by tractor or rubber-tired equipment.

The surface characteristics of each log were identified and measured after the trees were felled and before skidding. The relationship of these external characteristics of a log to its eventual lumber grades and yield becomes the basis for analysis to refine or develop log or tree grades.

Transportation and Scaling

The study logs from each area were rafted to the Alaska Wood Products, Inc., sawmill at Wrangell. Here a U.S. Forest Service representative applied the Puget Sound Log Scaling and Grading Bureau (1969) rules to all study logs.

The sample trees produced 1,261 sawn-length² logs. Tables 1 and 2 present the log distribution by length and grade for rafted or woods-length³ logs and for bucked or sawn-length logs.

The sawn-length logs included 0.2 percent Peeler grade logs, 4.3 percent No. 1 grade, 45.0 percent No. 2 grade, 42.9 percent No. 3 grade; the additional 7.6 percent of the logs were culled for defect.

Sawing

The study logs were sawn under nearly normal processing procedures and production rates at the Alaska Wood Products, Inc. mill. Production equipment included a band headsaw, cant gang saw, horizontal band resaw, and an edger. The sawmill cooperated by cutting the logs to recover optimum value of the logs consistent with their normal manufacturing procedures to produce rough green 4- by 4-inch items ("baby squares") for export.

Lumber Grading

All sawn items were graded under the supervision of a Pacific Lumber Inspection Bureau grader. He applied the West Coast Lumber Inspection Bureau Standard Grading and Dressing Rules (West Coast Lumber Inspection Bureau 1956) and placed each item into one of the following lumber grades:

B and Better Select	Construction
C Select	Standard
D Select	Utility
Select Structural	Economy

²Sawn-length logs are logs in lengths as rebucked in the mill.

³Woods-length logs are logs in lengths as bucked in the woods.

Table 1.--Distribution of woods-length, western hemlock logs
by length and log grade for southeast Alaska

Log length (feet)	Log grade ^{1/}				Cull	Total
	Peeler	No. 1	No. 2	No. 3		
<i>Number of logs</i>						
10	0	0	0	3	0	3
12	0	0	0	10	0	10
14	0	0	0	3	1	4
16	0	2	2	10	2	16
18	0	0	1	4	1	6
20	0	1	3	13	2	19
22	0	0	5	17	1	23
24	0	0	3	21	5	29
26	0	7	14	32	3	56
28	0	0	1	5	1	7
30	0	1	2	11	0	14
32	0	0	19	26	3	48
34	0	1	5	11	1	18
36	0	2	13	18	4	37
38	0	0	2	9	0	11
40	3	17	99	93	11	223
42	0	0	1	6	0	7
44	0	0	4	10	0	14
46	0	0	14	12	0	26
48	0	0	3	6	1	10
50	0	0	2	5	1	8
52	0	0	42	44	4	90
54	0	0	0	2	0	2
56	0	0	0	1	0	1
58	0	0	0	0	1	1
60	0	0	0	2	0	2
62	0	0	0	0	0	0
64	0	0	0	2	0	2
66	0	0	0	5	0	5
68	0	0	0	3	0	3
70	0	0	0	3	0	3
72	0	0	0	1	0	1
74	0	0	0	2	0	2
76	0	0	0	3	0	3
78	0	0	0	1	0	1
80	0	0	0	2	0	2
Total	3	31	235	396	42	707

^{1/} General Log Grading Rules for Sitka Spruce and
Western Hemlock. USDA Forest Service, 2441.4, Alaska
Region, 1959.

Table 2.--*Distribution of sawn western hemlock logs by length and log grade for southeast Alaska*

Log length (feet)	Log grade ^{1/}				Cull	Total
	Peeler	No. 1	No. 2	No. 3		
<i>Number of logs</i>						
10	0	0	0	5	0	5
12	0	0	32	29	12	73
14	0	0	120	58	21	199
16	0	1	21	27	5	54
18	0	0	26	39	2	67
20	1	29	164	143	32	369
22	0	1	15	29	6	51
24	0	0	25	42	4	71
26	2	23	164	162	14	365
28	0	0	0	7	0	7
Total	3	54	567	541	96	1,261

^{1/} General Log Grading Rules for Sitka Spruce and Western Hemlock. USDA Forest Service, 2441.4, Alaska Region, 1959.

Cubic Volume: Logs, Sawdust, and Coarse Chippable Residue

The gross cubic log volume (G.V.) was computed by the following formula:

$$G.V. = \pi L \frac{(D_1^2 + D_1 D_2 + D_2^2)}{12 \times 144};$$

where π = constant pi, 3.1416,

L = log scaling length in feet,

D₁ = log scaling diameter in inches, small end,

D₂ = log diameter in inches, large end.

Sawdust volumes were calculated using one-half the average saw kerf width and the computed surface area of the lumber from each log.

Coarse or chippable residue volume is the difference between gross cubic log volume and lumber volume plus sawdust volume. This indirect method of calculation includes the small amount of sawdust from the saw kerf of the slabs and edgings.

Results and Discussion

Table 3 summarizes the log scale, lumber tally, and cubic volume of the logs in the study for each log grade and for all grades combined. A more detailed breakdown of these results, including lumber grade yields by diameter and log grade, is presented in appendixes 1 and 2.

Appendix 1 presents the recovery volume and lumber grade yields by log grade and diameter classes for sawn-length logs; appendix 2 contains the same information for woods-length logs. For example, the average cubic recovery for No. 2 grade logs was 49 percent (see table 9) and for cull logs 26 percent (see table 11).

We included data for both sawn- and woods-length logs when we thought it might be of use and interest, but generally only the data for sawn-length logs are discussed.

Defect

Defect percentages by individual log grade and all grades combined are shown in table 3. The average defect percent for noncull, sawn-length logs was about 20 percent compared with about 22 percent for noncull, woods-length logs. The primary reason for the sawn-length logs having less scaled defect than the woods-length logs is that if the woods-length log is bucked at the mill, the defect in that log may be confined to one of the sawn-length logs. This may result in one of the sawn-length logs being culled.

Overrun, Lumber Recovery Factor, and Cubic Recovery

The average overrun for all noncull, sawn- and woods-length logs was 20 percent and 35 percent (120 and 135 recovery percent), respectively. The differences in overrun between log grades for both sawn- and woods-length logs are due to the diameter distributions between grades, to the various types and amounts of defects between grades, and to the relationship of both of these factors. Overrun as used here is board-foot lumber tally volume less net Scribner log scale divided by net scale times 100.

The 665 noncull, woods-length logs produced 315,481 board feet of lumber; when bucked, the noncull, sawn-length logs produced 309,187 board feet of lumber (table 3). As described above, this difference in lumber tally volume is due to some logs being considered cull when bucked into the sawn length. The total gross and net scales for all woods-length, noncull logs were 299,170 and 232,840 board feet, respectively.

Table 3.--Log scale, lumber tally, and cubic volume of sawn-and woods-length western hemlock logs by log grades used in southeast Alaska

Log grade	Number of logs	Log scale ^{1/}		Defect	Lumber tally			Cubic volume				
		Gross	Net		Volume	Recovery percent ^{2/}	Lumber recovery factor	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Residue
Sawn-length logs: ^{4/}												
		- - Board feet - -		Percent	Bd. ft./cu. ft. - - - Cubic feet- - -							
Peeler	3	2,620	2,310	11.8	2,878	125	8.04	358.15	240.23	67	32.40	85.52
No. 1	54	48,370	35,260	27.1	44,430	126	5.86	7,583.69	3,729.12	49	489.73	3,364.84
No. 2	567	206,270	163,990	20.5	192,017	117	5.83	32,957.21	16,080.96	49	2,143.95	14,732.30
No. 3	541	62,210	55,210	11.3	69,862	127	5.51	12,666.50	5,842.91	46	787.93	6,035.66
Total or weighted average	1,165	319,470	256,770	19.6	309,187	120	5.77	53,565.55	25,893.22	48	3,454.01	24,218.32
Woods-length logs: ^{4/}												
Peeler	3	4,350	3,620	16.8	4,675	129	5.66	826.05	390.69	47	52.70	382.66
No. 1	31	42,820	28,140	34.3	37,070	132	4.40	8,427.57	3,110.26	37	409.92	4,907.39
No. 2	235	169,980	132,380	22.1	172,367	130	5.17	33,351.32	14,442.43	43	1,921.07	16,987.82
No. 3	396	82,020	68,700	16.2	101,369	148	5.32	19,067.04	8,480.76	44	1,139.29	9,446.99
Total or weighted average	665	299,170	232,840	22.2	315,481	135	5.11	61,671.98	26,424.14	43	3,522.98	31,724.86

^{1/} Sawn-length logs: as scaled by Forest Service scaler, applying Puget Sound Log Scaling and Grading Bureau rules, Scribner Decimal C log rule. Woods-length logs: as scaled by Forest Service scaler, applying Puget Sound Log Scaling and Grading Bureau rules, Scribner Decimal C log rule.

^{2/} Lumber tally volume as a percent of net scale volume.

^{3/} Lumber cubic volume as a percent of log cubic volume.

^{4/} Cull logs not included.

The mix of log sizes and quality in this study resulted in a rough green lumber cubic volume recovery of approximately 43 percent from woods-length logs and 48 percent from sawn-length, noncull logs (table 3). This compares with 56-percent cubic-foot recovery from a sawn sample of woods-length Sitka spruce logs in southeast Alaska (Lane et al. 1972). By comparison, a series of old-growth Douglas-fir studies (Lane et al. 1973) in the Pacific Northwest had a 63-percent cubic-foot recovery from woods-length logs.

The LRF for this Alaska western hemlock study was 5.1 board feet per cubic foot of log volume for woods-length logs and 5.8 board feet per cubic foot for sawn-length logs (see table 3). These figures are based on nominal lumber or cant tally and gross cubic log volumes.

Lumber Grade Yields

Table 4 and figures 2 and 3 present the distribution of average lumber grade yields by log grades. There is a very noticeable decrease in the percentage of C and Better lumber from the Peeler log grade (45.8 percent) to the No. 3 log grade (1.1 percent). This is balanced by the increase in the percentage of Construction and Standard lumber for the same log grades: 37.0 percent to 58.5 percent.

Note in figure 2 the consistent production of Select Structural and Utility grades of lumber for all log grades. These two grades account for about 15 percent of the total study lumber tally but do not differ substantially between log grades.

Items 4 inches thick accounted for 88.2 percent of the lumber volume produced, whereas items 2 inches thick accounted for about 11.8 percent and 1-inch thick items for less than 0.1 percent. Lumber items measuring a nominal 4 by 4 inches accounted for 87.0 percent of the study volume.

Table 4.--Average lumber grade yields expressed as a percent of lumber tally volume by log grade for southeast Alaska
western hemlock

Log grade	Number of logs	Lumber tally volume	Lumber grades					
			C and Better Select	Select Structural	Construction	Standard	Utility	Economy
Sawn-length logs:			Board feet ----- Percent of lumber tally volume -----					
Peeler	3	2,878	45.76	4.14	20.60	16.47	8.55	4.48
No. 1	54	44,430	39.16	5.10	17.07	15.50	16.14	7.03
No. 2	567	192,017	15.02	10.84	25.38	22.13	20.54	6.09
No. 3	541	69,862	1.11	9.11	29.81	28.63	24.74	6.60
Total or average	1,165	309,187	15.60	9.60	25.20	22.60	20.70	6.30
Cull	96	26,234	22.67	2.10	12.41	18.75	33.72	10.35
Woods-length logs:								
Peeler	3	4,675	48.64	9.39	10.93	11.36	14.16	5.52
No. 1	31	37,070	41.63	5.80	18.11	14.01	14.00	6.45
No. 2	235	172,367	17.49	10.37	24.15	21.56	20.02	6.41
No. 3	396	101,369	2.58	9.20	29.02	26.96	25.75	6.49
Total or average	665	315,481	16.00	9.40	24.80	22.30	21.10	6.40
Cull	42	19,940	19.13	1.60	13.62	22.89	32.68	10.08

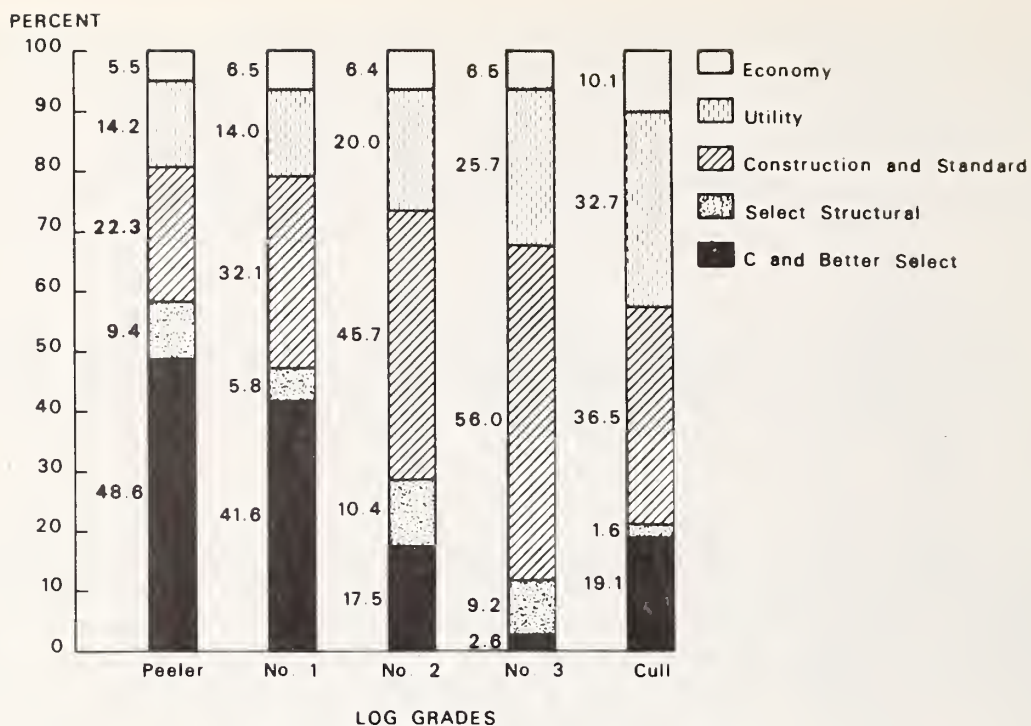


Figure 2.--Average yield from woods-length logs by lumber grade.



Figure 3.--Average yield from sawn-length logs by lumber grade.

From the sawn-length logs (fig. 3), Standard and Construction lumber grades accounted for at least 30 percent of the lumber grade recovery from any log grade, including culls. Further evidence of the yield of high value wood from cull logs is shown by the nearly 23-percent recovery in C and Better Select cants. For example, consider the cull 24-inch log in figure 4. The net scale of this log was 140 board feet. Actual lumber tally was 220 board feet. About 50 percent of this log's lumber recovery was Construction grade. The gross log volume was 71.9 cubic feet with 18.1 cubic feet (25.2 percent) recovered as lumber.

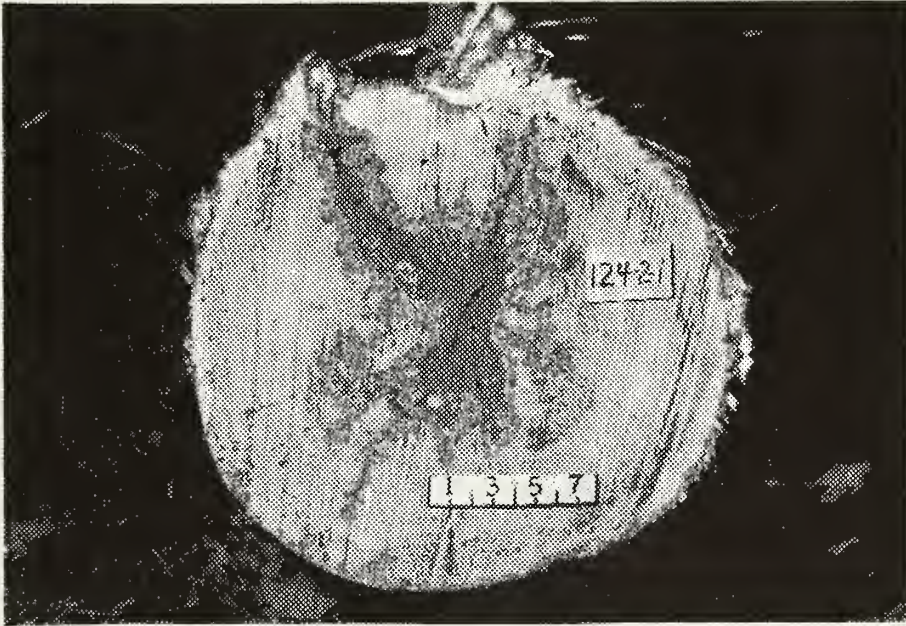


Figure 4.--A 24-inch cull western hemlock log with a gross scale of 450 board feet, net scale of 140 board feet, a lumber yield of 220 board feet, and 25.2-percent recovery of gross cubic-foot log volume.

Chip Recovery

The forest products industry is moving toward use of cubic volumes to express mill input and product output yields. Several grading and scaling bureaus now provide a cubic scale of logs if requested. Product yield studies and cubic log scaling studies underway recognize that board-foot volumes deducted for defects such as shake or checks may still produce high quality chips. Included in cubic scaling is the wood volume outside the Scribner log scaling cylinder.

Chip yield from sawn logs is presented in figures 5, 6, and 7. It is expressed as pounds of ovendry chips:

- (1) per cubic foot of gross log volume,
- (2) per cubic foot of lumber output, and
- (3) per thousand board feet, net Scribner scale, of logs.

POUNDS

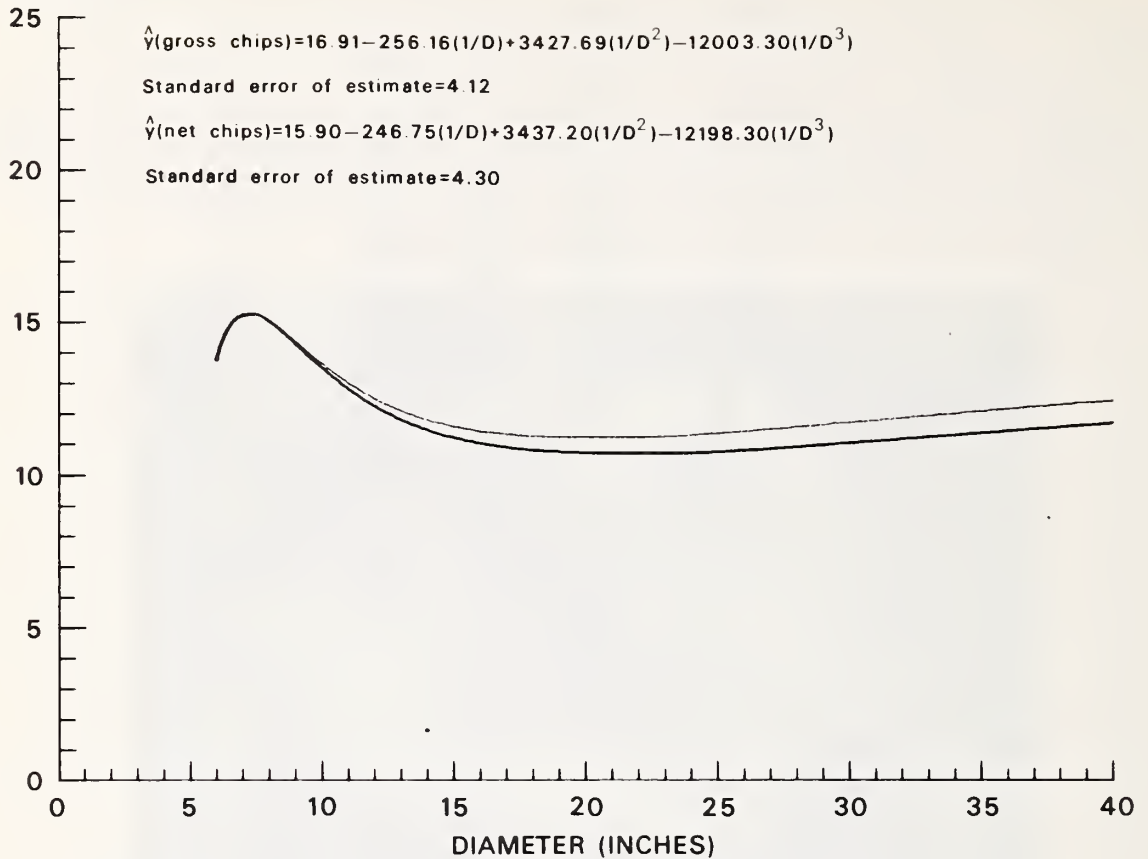


Figure 5.--Yields of oven-dry chips per cubic foot of log input over diameter.

POUNDS

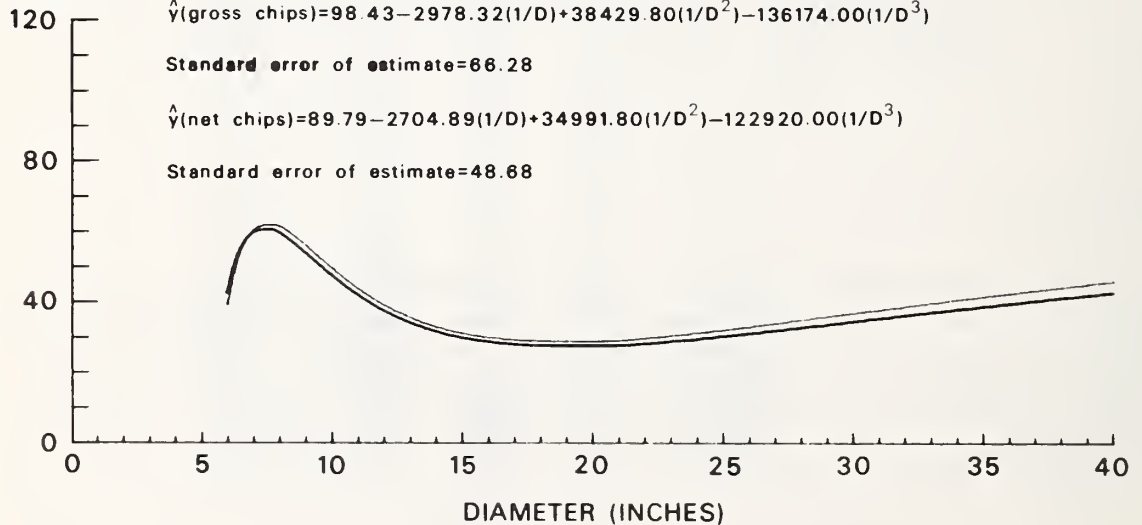


Figure 6.--Yields of oven-dry chips per cubic foot of lumber output over diameter.

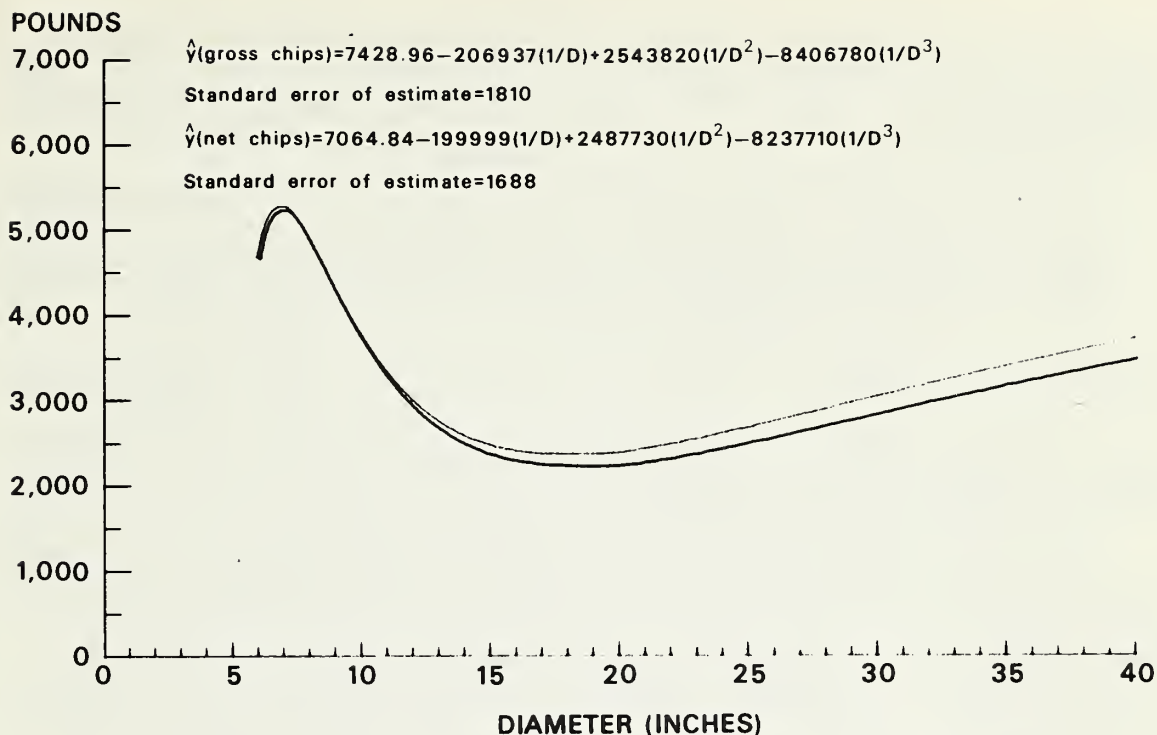


Figure 7.--Yields of oven-dry chips per thousand board feet (net Scribner scale) of log input over diameter.

Chip yields expressed as pounds per cubic foot of log volume recognize the forest products industry trend to express mill input and product output in cubic feet. Likewise, chip yields, in terms of pounds per cubic foot of lumber, recognize the Alaska export market where cants are transported by ship. Knowledge of the lumber volume placed in a ship's hold can be used to estimate the amount of chips that resulted from sawing the lumber. Finally, chip yields expressed as pounds per thousand board feet of logs are used because log volume into mills is still generally expressed as Scribner scale.

The calculations to convert cubic volumes to weight for each log require a wood density value in pounds per cubic foot (green weight and green volume) and an average wood moisture content. The following example uses a density value of 53.7 pounds per cubic foot and a 105-percent moisture content to illustrate the calculations to estimate pounds of oven-dry chips from an individual log. The log chosen for the example is the single 34-inch log in appendix table 8.

From appendix 1, table 8, determine that 134 cubic feet of gross chippable residue volume was produced from 215 cubic feet of sawn log volume.

Next, convert this cubic volume to green weight: (134 cubic feet) X (53.7 pounds per cubic foot of green density for western hemlock) = 7,196 pounds gross weight of chippable residue volume.

Convert green weight to ovendry weight using 105-percent average moisture content for western hemlock: $(7,196 \text{ pounds of chips}) \div (1 + \frac{105}{100} \text{ moisture content}) = 3,510 \text{ pounds}$, the ovendry weight of gross chippable residue volume.

Express pounds of ovendry chips on the per-unit basis noted earlier:

1. $(3,510 \text{ pounds of ovendry chips}) \div (215 \text{ cubic feet of log volume}) = 16.3 \text{ pounds of ovendry chips per cubic foot of gross log volume.}$
2. $(3,510 \text{ pounds of ovendry chips}) \div (72 \text{ cubic feet of lumber recovered}) = 48.7 \text{ pounds of ovendry chips per cubic foot of lumber output.}$
3. $(3,510 \text{ pounds of ovendry chips}) \div (740 \text{ board feet, net Scribner scale, of lumber}) (1,000) = 4,743 \text{ pounds of ovendry chips per 1,000 board feet, net Scribner scale, of lumber.}$

Chip weight calculated in above examples is expected to overestimate actual production of suitable chips because certain wood rots, in the decay stage termed "typical," render coarse wood residue unsuitable for chips. Therefore, to estimate a net residue cubic volume suitable for chip production, Dr. James W. Kimmey⁴ determined, during the sawing of each log, cubic volume of the rot, by type, in both the incipient and typical stages. These volumes have been used to adjust downward the calculated estimates of chippable residue volumes shown in figures 5, 6, and 7.

Note the shape of the curve in the lower diameters of figures 5, 6, and 7. The peak in the curve, at about 7 inches, was possible to identify because the curve form used was sensitive to this type of data variation. The product mix from small logs supports this curve. The 6- and 7-inch logs generally yielded a single 4- by 4-inch cant; thus, the proportion of chippable residue available from the 7-inch log was greater. Plotting individual log chip yields over diameter substantiates the curve form in the smaller diameters.

The proportion of lumber recovered increased from 8-inch to 15-inch logs, then remained fairly uniform to 20-inch logs. This is indicated by a decrease in the chip yield curves of figures 5, 6, and 7. In logs above 20 inches in diameter, a slight upward trend is evident, probably due to increased defect in larger logs, particularly in shake, which most frequently occurs in butt logs.

The chip yields presented in the curves of figures 5, 6, and 7 vary tremendously for individual logs within a diameter class. The standard errors are shown on the figures. The figure 5 standard error indicates a chip yield of pounds of ovendry chips per cubic foot of log input of 4.30 pounds. The reader should be aware of the variation when using the curves to predict chip yields of individual logs; however, diameter class averages can be expected to follow the curved relationship for reasonable size samples (i.e., probably in excess of 10 logs per diameter class).

⁴Forest pathologist, retired, U.S. Forest Service.

Consider, however, for discussion purposes, an example of the pounds of oven-dry chips per cubic foot of logs sawn. From figure 5, the amount estimated for the 25-inch-diameter sawn logs on a gross cubic log volume basis, not accounting for decay, is about 11.3 pounds. When a reduction in gross cubic log volume is made for areas of decay not suitable for chipping, the pounds per cubic foot drops to about 10.8. This small drop in the chip weight estimate can have a considerable effect on an estimate of chip production. For example, from 2 million cubic feet of logs, approximately 1 million fewer pounds of oven-dry chips are recoverable due to presence of decay not suitable for fiber production.

Woods Residue - Tree Utilization

There are increasing awareness and concern over the volume of residue developed during logging. Although this study was not designed to sample logging residue volume, the amounts by types are of interest and can generally be considered representative of similar areas and timber in southeast Alaska.

The top diameter utilization selected for this yield study was 8 inches. As can be seen in appendix table 18, 62 logs were bucked in the woods to 6- and 7-inch diameters.

The gross volume to total height of the 342 processed trees was 80,923⁵ cubic feet. A total of 62,105 cubic feet was converted to sawn logs which produced 28,088 cubic feet of lumber. The total sawn log volume also includes 8,540 cubic feet of cull logs.

Table 5 presents the classes of woods residue that were identified and show calculated cubic volumes of each. Table 6 shows the average size of log components. Trees are grouped by 10-inch d.b.h. classes. The sawn log volume was 76.8 percent of the tree volume.

⁵U.S. Department of Agriculture, Forest Service. Sept. 1955. Agriculture Handbook No. 92.

Table 5.--Sources of logging residue as percentages of western hemlock tree volume^{1/} for southeast Alaska

D.b.h. class (inches)	Trees in sample	Average gross volume per tree	Sawn log volume	Broken logs		Long butts		Unused to 8-inch top		Top ^{2/}	
				Trees with breaks	Number	Percent	Trees with long butts	Volume	Number	Percent	Volume
11.0-19.9	88	61.5	77.6	5	5	0.5	1	0.1	29	2.6	19.2
20.0-29.9	109	151.4	83.8	18	18	1.0	7	.9	70	3.1	11.2
30.0-39.9	88	305.7	83.1	41	41	2.5	17	4.3	69	3.9	6.2
40.0-49.9	48	533.4	69.3	27	27	4.5	16	9.8	40	3.6	12.8
50.0+	9	722.1	60.8	7	7	8.5	3	12.2	7	4.7	13.8
Total or weighted average	342	236.6	76.8	98	98	3.2	44	5.7	215	3/ 3.6	10.8

^{1/} Without deductions for rot.

^{2/} Measured from the used top or 8-inch top to total height.

^{3/} Includes cull logs left in the woods.

Table 6.--Average size of logging residue components from western hemlock for southeast Alaska

D.b.h. average of class (inches)	Sawn logs		Broken logs		Long butts		Unused to 8-inch top	
	Length	Top diameter	Length	Small diameter	Length	Small diameter	Length	Large diameter
	<u>Feet</u>	<u>Inches</u>	<u>Feet</u>	<u>Inches</u>	<u>Feet</u>	<u>Inches</u>	<u>Feet</u>	<u>Inches</u>
16.5	65	7.9	9.2	10.6	4.3	11.0	10.4	9.8
24.3	86	9.5	7.7	14.3	8.9	20.9	13.2	10.5
34.0	101	12.8	11.6	16.4	11.8	28.5	17.6	13.3
44.0	112	14.5	11.3	20.9	17.1	33.8	22.1	15.4
52.4	114	19.9	18.8	25.4	22.1	38.7	26.6	19.4

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Appendix 1

Summary tables of recovery volumes by log grade and diameter classes, bucked or sawn-length logs, southeast Alaska--tables 7-12.

Table 7.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--saw-length, western hemlock peeler grade logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of Peeler grade logs	Log scale ^{1/}		Lumber tally		Cubic volume				
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue
		-----Board feet-----				-----Cubic feet-----				
25	1	750	610	821	135	99.69	68.85	69	9.19	21.65
26	0	--	--	--	--	--	--	--	--	--
27	0	--	--	--	--	--	--	--	--	--
28	1	950	880	1,082	123	132.21	89.61	68	12.51	30.09
29	0	--	--	--	--	--	--	--	--	--
30	0	--	--	--	--	--	--	--	--	--
31	0	--	--	--	--	--	--	--	--	--
32	1	920	820	975	119	126.25	81.77	65	10.70	33.78
Total	3	2,620	2,310	2,878	125	358.15	240.23	67	32.40	85.52

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 8.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--sawn-length, western hemlock No. 1 grade
logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of No. 1 grade logs	Log scale ^{1/}		Lumber tally		Log	Cubic volume		
		Gross	Net	Volume	Recovery percent ^{2/}		Lumber	Lumber recovery percent ^{3/}	Chippable residue
		- - - - Board feet - - - -				- - - - Cubic feet - - - -			
24	5	3,140	2,500	3,412	136	456.14	287.55	63	131.24
25	4	2,640	2,200	2,581	117	497.10	217.19	44	251.31
26	7	5,410	4,180	4,625	111	820.11	388.23	47	380.94
27	6	4,290	3,380	3,948	117	569.69	332.73	58	194.20
28	3	2,850	2,390	2,868	120	470.51	241.06	51	197.92
29	7	5,630	4,110	5,183	126	889.90	434.10	49	398.07
30	5	4,350	3,160	4,010	127	605.39	336.21	56	225.74
31	4	3,820	2,490	3,630	146	698.33	303.33	43	353.80
32	2	1,840	1,190	1,458	123	273.33	122.02	45	135.05
33	4	4,210	2,690	4,122	153	640.21	345.31	54	249.60
34	1	1,000	740	852	115	214.82	71.91	33	133.73
35	3	3,600	2,300	2,884	125	539.75	241.90	45	265.92
36	0	--	--	--	--	--	--	--	--
37	0	--	--	--	--	--	--	--	--
38	0	--	--	--	--	--	--	--	--
39	1	1,820	1,420	1,698	120	250.57	142.35	57	89.39
40	1	1,500	920	1,215	132	270.56	102.01	38	155.20
41	0	--	--	--	--	--	--	--	--
42	0	--	--	--	--	--	--	--	--
43	1	2,270	1,590	1,944	122	387.28	163.22	42	202.73
Total	54	48,370	35,260	44,430	126	7,583.69	3,729.12	49	3,364.84

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 9.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--saw-length, western hemlock No. 2 grade
logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of No. 2 grade logs	Log scale ^{1/}		Lumber tally		Cubic volume					
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue	
-----Board feet-----											
14	40	5,750	5,480	6,302	115	1,106.06	526.89	48	71.24	507.93	
15	50	8,950	8,570	9,642	113	1,618.14	807.73	50	108.25	702.16	
16	62	12,900	11,870	13,253	112	2,329.70	1,109.30	48	148.59	1,071.81	
17	47	10,940	9,900	11,178	113	1,936.54	933.42	48	126.37	876.75	
18	46	12,560	10,980	12,175	111	2,086.02	1,019.64	49	136.07	930.31	
19	47	13,560	11,420	13,993	123	2,188.99	1,173.98	54	155.01	860.00	
20	43	15,550	12,880	15,062	117	2,516.43	1,260.56	50	169.80	1,086.07	
21	35	13,110	10,750	12,744	119	2,072.31	1,067.33	52	141.80	863.18	
22	38	16,750	13,550	15,876	117	2,719.85	1,331.03	49	175.60	1,213.22	
23	26	11,280	7,970	10,268	129	1,684.21	860.35	51	114.49	709.37	
24	28	14,450	10,840	12,966	120	2,226.00	1,085.85	49	144.44	995.71	
25	27	15,890	10,650	12,563	118	2,382.56	1,053.19	44	139.06	1,190.31	
26	18	10,210	7,720	9,174	119	1,458.31	768.13	53	102.43	587.75	
27	17	11,010	8,140	9,671	119	1,575.96	808.94	51	108.15	658.87	
28	11	8,020	5,630	7,643	136	1,125.66	637.76	57	86.64	401.26	
29	6	4,250	3,450	2,384	69	631.21	200.53	32	26.31	404.37	
30	8	5,820	4,180	4,514	108	822.07	381.03	46	48.77	392.27	
31	10	7,710	5,230	6,031	115	1,295.06	503.69	39	67.65	723.72	
32	3	2,940	1,700	2,078	122	435.79	174.59	40	23.13	238.07	
33	1	690	490	540	110	120.21	45.34	38	6.08	68.79	
34	2	2,000	1,300	2,269	175	364.21	189.81	52	25.32	149.08	
35	0	--	--	--	--	--	--	--	--	--	
36	1	810	700	875	125	125.76	73.32	58	9.82	42.62	
37	0	--	--	--	--	--	--	--	--	--	
38	0	--	--	--	--	--	--	--	--	--	
39	1	1,120	590	816	138	136.16	68.55	50	8.93	58.68	
Total	567	206,270	163,990	192,017	117	32,957.21	16,080.96	49	2,143.95	14,732.30	

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 10.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--saw-length, western hemlock No. 3 grade logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of No. 3 grade logs	Log scale ^{1/}		Lumber tally		Cubic volume					
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue	
- - - - -Board feet- - - - -											
6	11	330	330	511	155	104.99	44.27	42	5.56	55.16	
7	24	870	830	1,157	139	280.65	97.28	35	13.31	170.06	
8	49	1,920	1,880	2,825	150	613.52	236.36	39	32.13	345.03	
9	63	2,940	2,890	4,060	140	880.39	340.63	39	46.22	493.54	
10	61	4,290	4,050	4,934	122	982.12	413.58	42	55.62	512.92	
11	70	6,230	5,950	7,443	125	1,403.99	623.37	44	83.12	697.50	
12	72	7,480	7,190	9,320	130	1,646.15	779.06	47	104.93	762.16	
13	67	8,190	7,900	9,425	119	1,618.53	783.50	48	108.80	726.23	
14	39	5,640	5,110	6,200	121	1,155.41	518.81	45	69.73	566.87	
15	16	2,380	2,100	2,460	117	460.54	205.77	45	27.74	227.03	
16	13	2,560	2,160	2,901	134	468.93	242.46	52	32.87	193.60	
17	8	2,130	1,820	2,235	123	368.42	186.59	51	24.99	156.84	
18	11	2,600	2,270	2,254	99	409.94	188.59	46	25.13	196.22	
19	13	4,140	3,540	4,739	134	706.09	396.73	56	52.36	257.00	
20	11	3,850	3,170	4,084	129	609.58	340.59	56	46.19	222.80	
21	4	1,520	1,220	1,494	122	231.56	124.89	54	16.89	89.78	
22	3	1,420	1,180	1,555	132	208.43	130.04	62	17.43	60.96	
23	0	--	--	--	--	--	--	--	--	--	
24	1	450	300	75	25	71.86	6.25	9	.83	64.78	
25	2	1,150	540	642	119	153.81	53.92	35	7.09	92.80	
26	1	620	210	591	281	79.56	49.82	63	6.35	23.39	
27	1	890	340	595	175	128.05	49.91	39	6.61	71.53	
28	0	--	--	--	--	--	--	--	--	--	
29	1	610	230	362	157	83.98	30.49	36	4.03	49.46	
Total	541	62,210	55,210	69,862	127	12,666.50	5,842.91	46	787.93	6,035.66	

- ^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.
^{2/} Lumber tally as percentage of net scale volume.
^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 11.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--saw-length, western hemlock cull logs for southeast Alaska

Log scaling diameter (inches)	Number of cull logs	Log scale ^{1/}		Lumber tally		Cubic volume									
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue					
- - - - - Board feet - - - - -												- - - - - Cubic feet - - - - -			
9	1	40	--	26	--				14.65	2.26	15	.28	12.11		
10	1	60	--	77	--				12.68	6.40	50	.89	5.39		
11	1	80	--	69	--				20.11	5.80	29	.77	13.54		
12	3	340	40	390	975				80.50	32.82	41	4.27	43.41		
13	1	120	--	11	--				28.25	.81	3	.16	27.28		
14	0	--	--	--	--				--	--	--	--	--		
15	2	340	--	209	--				57.95	17.64	30	2.31	38.00		
16	1	120	--	7	--				21.29	.50	2	.10	20.69		
17	2	550	--	422	--				132.39	35.17	27	4.84	92.38		
18	1	190	--	88	--				39.17	7.36	19	.98	30.83		
19	3	930	--	546	--				151.52	45.44	30	6.17	99.91		
20	4	1,210	--	686	--				220.45	57.47	26	7.68	155.30		
21	5	1,760	--	551	--				289.42	46.20	16	6.23	236.99		
22	6	2,420	130	1,188	914				368.97	99.28	27	13.37	256.32		
23	3	1,550	--	1,044	--				260.59	87.27	33	11.79	161.53		
24	7	3,420	140	1,636	1,169				526.31	136.48	26	18.26	371.57		
25	3	1,840	--	543	--				321.97	44.55	14	6.54	270.88		
26	6	3,380	--	1,942	--				512.93	162.49	32	21.69	328.75		
27	3	1,780	--	824	--				256.45	69.39	27	8.89	178.17		
28	6	4,010	--	1,971	--				517.81	165.38	32	21.86	330.57		
29	6	4,030	--	1,232	--				644.20	103.34	16	13.64	527.22		
30	6	4,420	--	1,093	--				607.65	90.37	15	12.56	504.72		
31	3	2,040	--	352	--				307.12	29.25	10	4.04	273.83		
32	5	4,600	--	1,547	--				685.20	130.10	19	15.95	539.15		
33	3	2,940	--	1,886	--				374.71	158.39	42	20.97	195.35		
34	6	4,900	--	2,778	--				710.78	231.46	33	31.08	448.24		
35	3	3,060	360	1,784	496				576.35	149.66	26	19.78	406.91		
36	1	1,150	--	1,019	--				188.97	84.76	45	11.63	92.58		
37	2	2,320	--	1,090	--				367.78	92.08	25	11.97	263.73		
38	0	--	--	--	--				--	--	--	--	--		
39	1	980	--	322	--				125.30	27.36	22	3.34	94.60		
40	0	--	--	--	--				--	--	--	--	--		
41	0	--	--	--	--				--	--	--	--	--		
42	1	1,010	--	901	--				118.22	74.82	63	10.31	33.09		
Total	96	55,590	670	26,234	3,916				8,539.69	2,194.30	26	292.35	6,053.04		

Table 12.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--all sawn-length, western hemlock logs combined, for southeast Alaska

Log scaling diameter (inches)	Number of logs	Log scale ^{1/}		Lumber tally		Cubic volume				
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue
		- - - - - Board feet - - - - -				- - - - - Cubic feet - - - - -				
6	11	330	330	511	155	104.99	44.27	42	5.56	55.16
7	24	870	830	1,157	139	280.65	97.28	35	13.31	170.06
8	49	1,920	1,880	2,825	150	613.52	236.36	39	32.13	345.03
9	64	2,980	2,890	4,086	141	895.04	342.89	38	46.50	505.65
10	62	4,350	4,050	5,011	124	994.80	419.98	42	56.51	518.31
11	71	6,310	5,950	7,512	126	1,424.10	629.17	44	83.89	711.04
12	75	7,820	7,230	9,710	134	1,726.65	811.88	47	109.20	805.57
13	68	8,310	7,900	9,436	119	1,646.78	784.31	48	108.96	753.51
14	79	11,390	10,590	12,502	118	2,261.47	1,045.70	46	140.97	1,074.80
15	68	11,670	10,670	12,311	115	2,136.63	1,031.14	48	138.30	967.19
16	76	15,580	14,030	16,161	115	2,819.92	1,352.26	48	181.56	1,286.10
17	57	13,620	11,720	13,835	118	2,437.35	1,155.18	47	156.20	1,125.97
18	58	15,350	13,250	14,517	110	2,535.13	1,215.59	48	162.18	1,157.36
19	63	18,630	14,960	19,278	129	3,046.60	1,616.15	53	213.54	1,216.91
20	58	20,610	16,050	19,832	124	3,346.46	1,658.62	50	223.67	1,464.17
21	44	16,390	11,970	14,789	124	2,593.29	1,238.42	48	164.92	1,189.95
22	47	20,590	14,860	18,619	125	3,297.25	1,560.35	47	206.40	1,530.50
23	29	12,830	7,970	11,312	142	1,944.80	947.62	49	126.28	870.90
24	41	21,460	13,780	18,089	131	3,280.31	1,516.13	46	200.88	1,563.30
25	37	22,270	14,000	17,150	122	3,455.13	1,437.70	42	190.48	1,826.95
26	32	19,620	12,110	16,332	135	2,870.91	1,368.67	48	181.41	1,320.83
27	27	17,970	11,860	15,038	127	2,530.15	1,260.97	50	166.41	1,102.77
28	21	15,830	8,900	13,564	152	2,246.19	1,133.81	50	152.54	959.84
29	20	14,520	7,790	9,161	118	2,249.29	768.46	34	101.71	1,379.12
30	19	14,590	7,340	9,617	131	2,035.11	807.61	40	104.77	1,122.73
31	17	13,570	7,720	10,013	130	2,300.51	836.27	36	112.89	1,351.35
32	11	10,300	3,710	6,058	163	1,520.57	508.48	33	66.04	946.05
33	8	7,840	3,180	6,548	206	1,135.13	549.04	48	72.35	513.74
34	9	7,900	2,040	5,899	289	1,289.81	493.18	38	65.58	731.05
35	6	6,660	2,660	4,668	175	1,116.10	391.56	35	51.71	672.83
36	2	1,960	700	1,894	271	314.73	158.08	50	21.45	135.20
37	2	2,320	--	1,090	--	367.78	92.08	25	11.97	263.73
38	0	--	--	--	--	--	--	--	--	--
39	3	3,920	2,010	2,836	141	512.03	238.26	47	31.10	242.67
40	1	1,500	920	1,215	132	270.56	102.01	38	13.35	155.20
41	0	--	--	--	--	--	--	--	--	--
42	1	1,010	--	901	--	118.22	74.82	63	10.31	33.09
43	1	2,270	1,590	1,944	122	387.28	163.22	42	21.33	202.73
Total	1,261	375,060	257,440	335,421	130	62,105.24	28,087.52	45	3,746.36	30,271.36

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.



Appendix 2

Summary tables of recovery volumes by log grade and diameter classes, rafted or woods-length logs, southeast Alaska--tables 13-18.

Table 13.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--woods-length, western hemlock Peeler grade logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of Peeler grade logs	Log scale ^{1/}		Lumber tally		Cubic volume			
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Chippable residue
		----- Board feet -----				----- Cubic feet -----			
26	1	1,250	1,060	949	90	233.51	80.11	34	143.05
27	0	--	--	--	--	--	--	--	--
28	1	1,460	1,100	1,514	138	254.82	126.95	50	110.88
29	0	--	--	--	--	--	--	--	--
30	1	1,640	1,460	2,212	152	337.72	183.63	54	128.73
Total	3	4,350	3,620	4,675	129	826.05	390.69	47	382.66

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 14.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--woods--length, western hemlock No. 1
grade logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of No. 1 grade logs	Log scale ^{1/}		Lumber tally		Cubic volume				
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue
		--- Board feet ---				--- Cubic feet ---			--- Cubic feet ---	
24	4	3,690	3,020	4,057	134	900.54	341.65	38	44.38	514.51
25	2	2,300	1,880	2,155	115	463.24	180.79	39	23.35	259.10
26	3	3,190	2,250	3,281	146	598.44	274.98	46	36.10	287.36
27	2	2,740	2,130	3,390	159	585.85	282.80	48	38.83	264.22
28	3	3,500	2,400	2,773	116	656.83	233.12	35	30.43	393.28
29	4	6,080	3,710	3,698	100	1,269.88	310.80	24	40.92	918.16
30	0	--	--	--	--	--	--	--	--	--
31	3	4,270	2,140	3,192	149	867.60	268.13	31	35.02	564.45
32	2	3,040	2,140	2,787	130	599.36	232.76	39	31.02	335.58
33	3	5,390	3,720	4,841	130	1,199.20	406.92	34	53.78	738.50
34	0	--	--	--	--	--	--	--	--	--
35	0	--	--	--	--	--	--	--	--	--
36	0	--	--	--	--	--	--	--	--	--
37	0	--	--	--	--	--	--	--	--	--
38	1	1,070	380	816	215	132.76	68.55	52	8.93	55.28
39	2	3,640	2,360	2,921	124	489.04	244.53	50	32.48	212.03
40	1	1,500	670	1,215	181	270.56	102.01	38	13.35	155.20
41	0	--	--	--	--	--	--	--	--	--
42	0	--	--	--	--	--	--	--	--	--
43	0	--	--	--	--	--	--	--	--	--
44	1	2,410	1,340	1,944	145	394.27	163.22	41	21.33	209.72
Total	31	42,820	28,140	37,070	132	8,427.57	3,110.26	37	409.92	4,907.39

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 15.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--woods--length, western hemlock No. 2
grade logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of No. 2 grade logs	Log scale ^{1/}		Lumber tally		Cubic volume			
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Chippable residue
		----- Board feet -----				----- Cubic feet -----			
14	20	6,940	6,460	8,369	130	1,764.37	699.46	40	94.88
15	32	12,450	11,150	13,237	119	2,763.89	1,108.61	40	148.42
16	20	8,690	7,830	10,208	130	1,933.80	854.94	44	114.69
17	17	8,480	7,870	10,061	128	1,818.88	844.19	46	112.23
18	25	14,640	11,800	15,942	135	3,108.12	1,335.08	43	178.03
19	17	10,610	8,250	10,931	132	2,086.04	915.33	44	121.85
20	14	11,310	8,710	12,249	141	2,228.14	1,024.73	46	137.19
21	22	17,710	14,270	18,322	128	3,772.56	1,532.75	41	204.98
22	14	11,750	9,400	11,642	124	2,159.77	978.92	45	128.33
23	8	8,140	6,490	8,149	126	1,570.44	684.21	44	89.80
24	13	14,530	11,380	13,663	120	2,567.14	1,145.25	45	151.17
25	7	6,780	4,800	6,895	144	1,203.17	578.09	48	77.20
26	4	5,640	3,690	5,026	136	1,154.40	419.55	36	56.44
27	6	7,810	4,940	7,087	143	1,203.56	593.06	49	79.27
28	4	6,230	4,010	5,189	129	1,042.53	436.45	42	56.50
29	4	6,270	3,940	6,343	161	1,027.55	532.20	52	70.39
30	3	4,560	3,040	3,935	129	778.75	331.77	43	42.56
31	2	2,300	1,910	1,922	101	335.61	160.24	48	21.71
32	0	--	--	--	--	--	--	--	--
33	2	3,720	1,670	1,716	103	592.52	143.45	24	19.06
34	0	--	--	--	--	--	--	--	--
35	1	1,420	770	1,481	192	240.08	124.15	52	16.37
Total	235	169,980	132,380	172,367	130	33,351.32	14,442.43	43	1,921.07
									16,987.82

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 16.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--woods--length, western hemlock No. 3
grade logs^{1/} for southeast Alaska

Log scaling diameter (inches)	Number of No. 3 grade logs	Log scale ^{1/}		Lumber tally		Cubic volume			
		Gross	Net	Volume	Recovery/ percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust
		- - - - Board feet - - - -				- - - - Cubic feet - - - -			
6	28	4,970	4,550	5,413	119	1,548.58	455.84	29	60.43
7	34	3,230	3,080	3,941	128	917.86	330.51	36	44.90
8	53	5,730	5,400	8,329	134	1,744.42	697.41	40	542.45
9	49	5,850	5,410	7,997	148	1,560.65	668.48	43	953.48
10	38	5,680	5,300	6,853	129	1,365.22	571.58	42	89.73
11	45	8,930	7,840	11,171	142	2,229.76	932.55	42	78.77
12	44	9,480	8,520	12,936	152	2,293.05	1,085.52	47	126.45
13	32	7,420	6,800	9,543	140	1,636.79	796.30	49	143.82
14	23	5,450	4,550	7,473	164	1,241.50	624.35	50	108.32
15	9	2,010	1,410	2,457	174	424.68	205.85	48	83.85
16	5	2,000	1,690	2,335	138	415.87	194.58	47	27.60
17	8	2,680	1,950	2,576	132	470.34	215.57	46	26.35
18	4	2,100	1,410	2,777	197	427.93	231.94	54	28.64
19	11	6,220	4,890	7,529	154	1,166.98	629.08	54	30.62
20	3	1,920	1,090	2,398	220	361.92	201.42	56	165.37
21	3	2,280	1,390	2,099	151	395.69	175.91	54	84.66
22	1	1,320	1,030	1,518	147	185.62	127.74	44	26.37
23	2	1,320	720	1,428	198	203.03	119.33	69	23.37
24	1	350	190	301	158	53.78	25.30	59	16.49
25	0	--	--	--	--	--	--	47	16.20
26	1	820	540	987	183	115.48	82.43	47	3.29
27	0	--	--	--	--	--	--	--	--
28	0	--	--	--	--	--	--	--	--
29	1	1,370	460	610	133	188.95	51.48	27	11.09
30	0	--	--	--	--	--	--	--	--
31	1	890	480	698	145	118.94	57.59	48	6.67
Total	396	82,020	68,700	101,369	148	19,067.04	8,480.76	44	8.14
									1,139.29
									9,446.99

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 17.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--woods-length, western hemlock cull logs for southeast Alaska

Log scaling diameter (inches)	Number of cull logs	Log scale ^{1/}		Lumber tally		Cubic volume				
		Gross	Net	Volume	Recovery percent ^{2/}	Log	Lumber	Lumber recovery percent ^{3/}	Sawdust	Chippable residue
		----- 5000 ² feet -----				----- Cubic feet -----			----- Cubic feet -----	
8	1	30	--	45	--	8.84	3.84	43	.48	4.52
9	1	100	--	90	--	28.86	7.41	26	1.10	20.35
10	0	--	--	--	--	--	--	--	--	--
11	1	500	--	122	--	101.33	9.90	10	1.48	89.95
12	0	--	--	--	--	--	--	--	--	--
13	0	--	--	--	--	--	--	--	--	--
14	1	170	--	93	--	35.91	7.70	21	1.09	27.12
15	0	--	--	--	--	--	--	--	--	--
16	1	180	--	114	--	28.41	9.54	34	1.25	17.62
17	2	530	--	368	--	88.80	30.74	35	4.13	53.93
18	2	1,390	--	1,286	--	217.77	108.18	50	14.02	95.57
19	2	1,960	--	1,203	--	348.80	100.78	29	13.26	234.76
20	1	560	--	420	--	84.71	35.39	42	4.79	44.53
21	2	1,440	--	831	--	260.81	69.07	26	9.43	182.31
22	4	3,050	450	2,311	514	547.28	194.24	35	25.51	327.53
23	4	3,440	210	1,264	602	559.74	105.24	19	14.26	440.24
24	2	1,560	--	768	--	232.28	64.26	28	8.58	159.44
25	5	5,120	--	2,515	--	866.33	207.08	24	28.80	630.45
26	0	--	--	--	--	--	--	--	--	--
27	1	1,880	--	117	--	420.98	9.43	2	1.50	410.05
28	1	1,160	--	436	--	162.72	37.14	23	4.71	120.87
29	4	3,720	--	2,012	--	650.69	166.56	26	23.52	460.61
30	2	3,280	--	358	--	648.32	30.01	5	3.91	614.40
31	2	2,930	--	1,653	--	475.76	139.79	29	16.90	319.07
32	1	1,470	--	316	--	220.67	25.46	12	3.91	191.30
33	1	1,960	--	1,733	--	291.54	145.66	50	18.82	127.06
34	1	2,000	--	1,885	--	360.92	155.96	43	21.93	183.03
Total	42	38,430	660	19,940	3,021	6,641.47	1,663.38	25	223.38	4,754.71

^{1/} As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/} Lumber tally as percentage of net scale volume.

^{3/} Lumber cubic volume as percentage of log cubic volume.

Table 18.--Summary of log scale, lumber recovery, and cubic volumes by diameter classes--all woods--length, western hemlock logs combined, for southeast Alaska

Log scaling diameter (inches)	Number of logs	Log scale-- ^{1/}		Lumber tally		Cubic volume			
		Gross	Net	Volume	Recovery percent-- ^{2/}	Log	Lumber	Lumber recovery percent-- ^{3/}	Chippable residue
		Board feet				Cubic feet			Cubic feet
6	28	4,970	4,550	5,413	119	1,548.58	455.84	29	60.43
7	34	3,230	3,080	3,941	128	917.86	330.51	36	44.90
8	54	5,760	5,400	8,374	155	1,753.26	701.25	40	94.01
9	50	5,950	5,410	8,087	149	1,589.51	675.89	43	90.83
10	38	5,680	5,300	6,853	129	1,365.22	571.58	42	78.77
11	46	9,430	7,840	11,293	144	2,331.09	942.45	40	127.93
12	44	9,480	8,520	12,936	152	2,293.05	1,085.52	47	143.82
13	32	7,420	6,800	9,543	140	1,636.79	796.30	49	108.32
14	44	12,360	11,010	15,935	145	3,041.78	1,331.51	44	179.82
15	41	14,460	12,560	15,694	125	3,188.57	1,314.46	41	176.02
16	26	10,870	9,520	12,657	133	2,378.08	1,059.06	45	142.29
17	27	11,690	9,820	13,005	132	2,378.02	1,090.50	46	145.00
18	31	18,130	13,210	20,005	151	3,753.82	1,675.20	45	222.67
19	30	18,790	13,140	19,663	150	3,601.82	1,645.19	46	219.77
20	18	13,790	9,800	15,067	154	2,674.77	1,261.54	47	168.35
21	27	21,430	15,660	21,252	136	4,429.06	1,777.73	40	237.78
22	19	16,120	10,880	15,471	142	2,892.67	1,300.90	45	170.33
23	14	12,900	7,420	10,841	146	2,333.21	908.78	39	120.26
24	20	20,130	14,590	18,789	129	3,753.74	1,576.46	42	207.42
25	14	14,200	6,680	11,565	173	2,532.74	965.96	38	129.35
26	9	10,900	7,540	10,243	136	2,101.83	857.07	41	113.98
27	9	12,430	7,070	10,594	150	2,210.39	885.29	40	119.60
28	9	12,350	7,510	9,912	132	2,116.90	833.66	39	108.63
29	13	17,440	8,110	12,663	156	3,137.07	1,061.04	34	141.50
30	6	9,480	4,500	6,505	145	1,764.79	545.41	31	71.83
31	8	10,390	4,530	7,465	165	1,797.91	625.75	35	81.77
32	3	4,510	2,140	3,103	145	820.03	258.22	31	34.93
33	6	11,070	5,390	8,290	154	2,083.26	696.03	33	91.66
34	1	2,000	--	1,885	--	360.92	155.96	43	21.93
35	1	1,420	770	1,481	192	240.08	124.15	52	16.37
36	0	--	--	--	--	--	--	--	--
37	0	--	--	--	--	--	--	--	--
38	1	1,070	380	816	215	132.76	68.55	52	8.93
39	2	3,640	2,360	2,921	124	489.04	244.53	50	32.48
40	1	1,500	670	1,215	181	270.56	102.01	38	13.35
41	0	--	--	--	--	--	--	--	--
42	0	--	--	--	--	--	--	--	--
43	0	--	--	--	--	--	--	--	--
44	1	2,410	1,340	1,944	145	394.27	163.22	41	21.33
Total	707	337,600	233,500	335,421	144	68,313.45	28,087.52	41	3,746.36
									36,479.57

^{1/}As scaled and graded by Forest Service check scaler according to the Puget Sound Log Scaling and Grading Bureau rules.

^{2/}Lumber tally as percentage of net scale volume.

^{3/}Lumber cubic volume as percentage of log cubic volume.



Woodfin, Richard O., Jr., and Thomas A. Snellgrove
1976. Western hemlock in southeast Alaska--utilization,
lumber recovery, and chip yield. USDA For. Serv.
Res. Pap. PNW-208, 33 p., illus. Pacific Northwest
Forest and Range Experiment Station, Portland, Oregon.

Lumber recovery from western hemlock from southeast Alaska.
National Forest land is presented with cubic volume yields,
cull log lumber recovery, estimates of chippable wood, and
logging residue from sample trees.

KEYWORDS: Western hemlock, *Tsuga heterophylla*, wood utiliza-
tion, lumber yield studies, sawmill recovery studies,
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The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

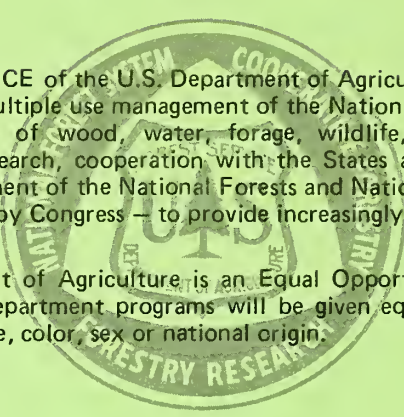
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1. Providing safe and efficient technology for inventory, protection, and use of resources.
2. Developing and evaluating alternative methods and levels of resource management.
3. Achieving optimum sustained resource productivity consistent with maintaining a high quality forest environment.

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